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TRANSACTIONS
OF THE
AMERICAN INSTITUTE
OF
ELECTRICAL ENGINEERS.

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RALPH W. POPE, *Secretary*,
26 CORTLANDT STREET, NEW YORK CITY.
Telephone, 2199 Cortlandt.

OFFICERS AND MEMBERS OF THE COUNCIL.

1898-99

PRESIDENT:

Dr. A. E. KENNELLY.
Term expires 1899.

PAST-PRESIDENTS:

Dr. NORVIN GREEN, 1884-5-6.
FRANKLIN L. POPE, 1886-7.
T. COMMERFORD MARTIN, 1887-8.
EDWARD WESTON, 1888-9.
Prof. ELIHU THOMSON, 1889-90.
Prof. W. A. ANTHONY, 1890-91.
ALEX. GRAHAM BELL, 1891-2.
FRANK J. SPRAGUE, 1892-93.
Dr. EDWIN J. HOUSTON, 1893-4-5
Dr. LOUIS DUNCAN, 1895-6-7.
Dr. FRANCIS B. CROCKER, 1897-8.

VICE-PRESIDENTS:

Terms expire 1899.
CHARLES S. BRADLEY,
Prof. DUGALD C. JACKSON.
C. O. MAILLOUX.

Terms expire 1900.
Prof. ROBERT B. OWENS,
WILLIAM STANLEY.
Dr. CARY T. HUTCHINSON.

MANAGERS:

Terms expire 1899.
JOHN W. LIEB, Jr.,
F. A. PICKERNELL,
WILLIAM L. PUFFER,
L. B. STILLWELL.

Terms expire 1900.
Dr. ALEXANDER MACFARLANE,
GANO S. DUNN,
W. F. C. HASSON,
HERBERT LAWS WEBB.

Terms expire 1901
HERBERT LLOYD,
SAMUEL SHELDON,
GEORGE F. SEVER,
CHARLES P. STEINMETZ,

Terms expire 1899.

TREASURER:

GEORGE A. HAMILTON,
87 Bethune Street, New York.

SECRETARY:

RALPH W. POPE,
26 Cortlandt St., New York.

Board of Examiners:

WILLIAM MAVER, Jr.
CHAS L. CLARKE.
JAMES B. CAHOON,
TOWNSEND WOLCOTT.
ROBERT N. BAYLIS.

Standing Committees appointed by direction of Council:

Executive Committee:

Dr. A. E. KENNELLY, Chairman.
GEO. A. HAMILTON,
Dr. CARY T. HUTCHINSON,
J. W. LIEB, Jr.,
F. A. PICKERNELL.
R. W. POPE,
HERBERT LAWS WEBB.

Committee on Papers and Meetings.

HERBERT LAWS WEBB, Chairman. Dr. FRANCIS B. CROCKER, T. C. MARTIN,
A. E. KENNELLY, Dr. M. I. PUPIN.

Committee on Units and Standards.

A. E. KENNELLY, Chairman. GEO. A. HAMILTON, DR. WM. E. GEYER,
FRANCIS B. CROCKER. WILLIAM D. WEAVER.

Committee on Standardization.

Dr. FRANCIS B. CROCKER, Chairman.
Dr. CARY T. HUTCHINSON, Dr. ARTHUR E. KENNELLY, JOHN W. LIEB, Jr.
CHARLES P. STEINMETZ, L. B. STILLWELL, Prof. ELIHU THOMSON

Committee on Membership, etc.,

RALPH W. POPE, Chairman
THOMAS D. LOCKWOOD, Local Secretary, Boston, Mass.,
Dr. LOUIS DUNCAN, " " Baltimore, Md.,
CARL HERING, " " Philadelphia, Pa.,
Prof. EDWARD L. NICHOLS, " " Ithaca, N. Y.,
JOSEPH WETZLER, " " New York City.
H. A. FOSTER, " " Buffalo, N. Y
Dr. F. A. C. PERRINE, " " Palo Alto, Cal.

Prof. WILBUR M. STINE, Local Honorary Secretary,
Armour Institute Chicago Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

New York, May 17th, 1898.

The annual business meeting of the Institute was held this date, and was called to order by President Crocker at 8:35 P. M.

The following associate members were elected at the meeting of the Executive Committee in the afternoon:

Name.	Address.	Endorsed by
Cadou, Felix Louis.	Superintendent and Electrician, Washington Street Railway Co., Washington, Ind.	F. S. Hunting. A. A. Serva. W. J. Hammer.
Dempster, Thomas.	Electrical Engineer, General Electric Co., Schenectady, N. Y.	Chas. P. Steinmetz. Eskil Berg. James Lyman.
Letheule, Paul	Electrical Engineer, Commissioned by French Government, 24 Front St., Schenectady, N. Y.	Chas. P. Steinmetz. Ernest Berg. James Lyman,
Johnston, Livingston, Jr.	Islip, N. Y.	W. H. Ripley. F. B. Crocker. W. H. Freedman.
Joslyn, Howard	Assistant Engineer, Snoqualmie Falls Power Co., Seattle, Wash.	D. C. Jackson. B. J. Arnold. R. W. Pope.
Mahoney, James J.	Engineering Assistant to Manager Railway Dep't. General Electric Co., 115 W. 47th St., New York City.	W. B. Potter. W. J. Clark. G. F. Sever.
Taylor, Irving A.	Motor Inspector, Edison Electric Illuminating Co., 360 Pearl St., Brooklyn, N. Y.	Jos. Wetzler. W. D. Weaver. C. J. Field.
Turnbull, Wallace Rupert.	Foreman of Experimental Room, General Electric Lamp Works; residence, 29 S. Arlington Ave., East Orange, N. J.	Jno. W. Howell, J. T. Marshall. W. S. Howell.
Winfield, James H.	Sup't. Eastern Division, Nova Scotia Telephone, Ltd., New Glasgow, N. S.	Norman Ross. F. A. Bowman. A. R. Cogswell.
Wood, Fred. W.	General Manager, Los Angeles Railway Co., 1722 S. Flower St., Los Angeles, Cal.	Frank Van Vleck. W. F. C. Hasson. Harrison C. Wybro.

Total 10.

TRANSFERRED FROM ASSOCIATE TO FULL MEMBERSHIP.

Approved by Board of Examiners, April 2nd, 1898.

BURCH, EDWARD P.	Electrical Engineer, Twin City Rapid Transit Co., Minneapolis, Minn.
REDMAN, G. A.	Gen'l Sup't. Electrical Dep't Brush Electric Light Co. and Rochester Gas and Electric Co., Rochester, N.Y.
BOGGS, L. S.	Pioneer Electric Co., Ogden, Utah.
FISCHER, GUSTAVE J.	Engineer for Tramway Construction, Public Works, Dept., Sydney, N. S. W.
SCOTT, JAMES B.	Electrician and Mechanical Engineer, 227 East German St., Baltimore, Md.

Total 5.

The President appointed Townsend Wolcott and J. P. Wintringham as tellers, and Prof. W. A. Anthony, C. S. Bradley and Charles Blizard as a Proxy Committee.

The following reports of the Council and of the Treasurer were read and accepted :

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

REPORT OF COUNCIL FOR THE YEAR ENDING APRIL 30TH, 1898.

NEW YORK, May 17, 1898.

As required by the Constitution, the Council presents for the information of the INSTITUTE at large, a report of its work and the financial standing of the organization at the close of the year.

Three meetings of the Council, and eight meetings of the Executive Committee have been held during the year.

Badges of the new design referred to in the last report of Council, have since been manufactured for sale, and 150 have been sold to the membership. The different styles are kept in stock so that there has been no delay in furnishing them. They are numbered consecutively as purchased and usually forwarded the day following the receipt of order. About 232 of the previous design are still outstanding, 32 having been returned for exchange.

The monthly meetings during the past season have been held on the fourth instead of the third Wednesday of each month This change was made in order to avoid conflicting dates with the meetings of the American Society of Civil Engineers, as many of our members belong also to that society.

A change has been made in the application blanks used by candidates for membership, separate forms now being used for associate members and for subsequent application for transfer. The old form used for both purposes gave rise to some confusion which is now avoided.

The National Electrical Code, which was formulated by the National Conference on Standard Electrical Rules, was submitted to the INSTITUTE for approval accompanied by a report by Dr. Francis B. Crocker, who was the official delegate representing the INSTITUTE in the conference. The Code was submitted for discussion by the members at meetings held in New York and Chicago, September 29th, 1897. The Code was approved, and by recommendation of the meeting, a committee was subsequently appointed by Council to report to the INSTITUTE any revisions which in its judgment are advisable. Certain recommendations have already been made by this committee which is composed of the following members:

CARY. T. HUTCHINSON, Chairman.
A. E. KENNELLY,
S. DANA GREENE.

By direction of the Executive Committee, the Committee on Papers and Meetings was authorized to arrange for a meeting to discuss the question of the Standardization of Dynamos, Motors and Transformers. This meeting was held at New York and Chicago, January 26th, 1898. After a thorough discussion the whole matter was referred to Council, which at its meeting March 23d, appointed the following committee to consider and report upon the subject:

FRANCIS B. CROCKER, Chairman.
CARY T. HUTCHINSON,
A. E. KENNELLY,
J. W. LIEB, Jr.,
C. P. STEINMETZ,
L. B. STILLWELL,
ELIHU THOMSON.

This committee has already held two meetings, but on account of the nature of its work, no final result has yet been reached, although very satisfactory progress has been made.

In accordance with instructions given by Council last year an account has been opened with the State Trust Company, in which the amount of $600 has been deposited which will be known and reported hereafter as the Compounded Membership Fund, drawing interest at 2 per cent.

In renewing the lease of the INSTITUTE's headquarters in the Havemeyer Building, a slight change has been made in the arrangement, by which a separate and more commodious office has been secured at the same rental for the use of the Secretary and for committee meetings.

At the meeting of Council January 26th, it was voted that the next General Meeting of the INSTITUTE be held at Omaha, Neb., and the date of its opening was subsequently fixed for June 27th.

The total membership at the close of last year's report was 1,073, classified as follows:

Honorary Members	2
Members	350
Associate Members	721
Total	1,073
Restored to Membership	2
Associate Members elected May 1st, 1897, to April 30th, 1898	89
" " " previous year and since qualified	8
Total	1,172

Resignations have been received during the year and accepted from the following members in good standing:

CHARLES L. EIDLITZ,
STANLEY G. FLAGG, Jr.,
EDWIN H. HALL,
FRANCIS R. HART,
E. M. IZARD,
LAWRENCE A. McCARTHY,
F. J. A. McKITTRICK,
W. G. M. THOMPSON,
LEONARD C. WASON,
FRANK P. MILLS.
JAMES W. CROSBY,
CHARLES D. SHAIN,
J. P. B. FISKE,
G. P. WARDELL,
C. H. SHARP,
A. G. WEBSTER,
P. R. MIDDLEMISS,
LOUIS S. WRIGHT,
WM. HOCHHAUSEN,
GEO. W. TUTTLE,

Total resignations 20

There have been the following deaths during the year:

JAMES E. GRIST,	GUSTAV A. LIEBIG, Jr.,
ARTHUR DE LA M. LOZIER,	HORACE S. L. VERLEY,
NORMAN R. WEAVER,	WM. H. COTHREN,
WM. W. GRISCOM,	O. B. SHALLENBERGER,
NELSON W. PERRY.	

Total deaths	9	
Dropped as delinquent	28	
Elections cancelled	1	
Elected but not yet qualified	16	74
		1,098

Leaving a total membership of 1,098 on April 30th, (a net gain of 25), classified as follows:

Honorary Members	2
Members	352
Associate Members	744
	1,098

A list of the members elected during the year accompanies this report. The names have already appeared in the TRANSACTIONS.

The reports of the Secretary and of the Treasurer show in detail the financial standing of the INSTITUTE at the close of the fiscal year, together with an itemized statement of receipts and disbursements during the entire year:

SECRETARY'S BALANCE SHEET.

FOR THE FISCAL YEAR ENDING APRIL 30, 1898.

Dr.		*Cr.*	
Receipts for the year	$10,027 01	By cash to Treasurer	$9,805 61
		Cash on hand	221 40
	$10,027 01		$10,027 01

ITEMIZED STATEMENT OF RECEIPTS AND DISBURSEMENTS OF THE INSTITUTE.

FOR FISCAL YEAR ENDING APRIL 30, 1898.

GENERAL ACCOUNT.

Receipts.		*Disbursements.*	
Treasurer's balance from previous year	$1,284 06	Chicago Meetings	$37 00
Entrance Fees	425 00	Library	4 50
Life Membership (C. T. Hutchinson).	100 00	Ice	26 60
Past Dues	655 64	Laundry	9 75
Current Dues	7,879 79	Office Expenses	26 69
Advance Dues	80 00	" Fixtures	18 55
Electrotypes Sold	8 36	Express	117 36
Transactions Sold	445 71	Telegrams	4 99
Transactions Subscriptions	211 50	Stenography and Typewriting	845 83
Advertising	149 92	Stationery and Miscellaneous Printing	369 06
Received for Binding	33 50	Postage	425 97
" " Certificates	2 00	Messenger Service	3 95
" " Congress Book	19 79	Salary Account	2,500 00
" " Reprints Vol. 4	15 80	Meeting Expenses	198 09
		Rent Office and Auditorium	1,095 00
		Copyright	5 00
		Engraving and Electrotyping	489 78
		Binding	193 22
		Publishing Transactions	2,627 99
		Design for Badge	26 00
		Engrossing	11 25
		Compounded Members'ip Fund	600 00
		Secretary's Balance to next year	221 40
		Treasurer's Balance to next year	1,453 09
	$11,311 07	Total,	$11,311 07

COMMERCIAL DEPARTMENT.

Dr.		*Cr.*	
Cash from previous year	$162 07	Badges, etc., bought	$497 28
Sales to May 1st	355 75	Engraving Names	35 04
		Badges on hand	137 00
		Bills Receivable	25 00
		Cash on Hand	23 50
	$717.82		$717 82

All outstanding bills against the INSTITUTE, were paid in full April 27th....
There is due the INSTITUTE and probably collectible.................. ..... $760 00

Property on hand according to inventory May 1, 1898.

Office furniture and fittings	$209 79
Catalogue Type, Cases, etc	233 78
Transactions on hand	3,107 79
Congress Books	764 71
Library	204 50
	$4,520 57

TOTAL NET ASSETS.

Building Fund	$973 48
Treasurer's Balance Mercantile Bank	1,453 09
Secretary's Balance, Cash on Hand	221 40
Secretary's Commercial Fund	185 50
Compounded Membership Fund in State Trust Co	600 00
Property as per Inventory	4,520 57
	$7,954 04

Respectfully submitted for the Council,

RALPH W. POPE,
Secretary.

New York, May 17, 1898.

TREASURER'S REPORT.

FROM APRIL 30, 1897 TO MAY 1, 1898.

GEORGE A. HAMILTON, TREASURER, in account with
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Dr.

Balance from May, 1897	$1,284 06	
Received from Secretary, April 30, 1897 to May 1, 1898	9,805 61	$11,089 67

Cr.

Payments from May 1, 1897, on warrants from Secretary, Nos. 879 to 996 inclusive	$9,636 58	
Balance to new account	1,453 09	$11,089 67

BUILDING FUND.

(Mercantile Trust Co.)

Balance as per last report	$850 00	
Interest accrued to May 1, 1898	123 48	$973 48

COMPOUNDED MEMBERSHIP FUND.

(State Trust Co.)

Cash from General Fund, Oct. 1, 1897	$500 00
Life Membership, C. T. Hutchinson	100 00
	$600 00

Cash book and warrants herewith for audit. Vouchers are in the hands of the Secretary, to whom they are returned for filing after payment.

GEORGE A. HAMILTON,
Treasurer.

New York, May 17, 1898,

The Tellers subsequently submitted the following report:

FOR PRESIDENT.

Total Number of Votes Cast .341

Arthur E. Kennelly	293	Thomas A. Edison	2
Francis B. Crocker	24	Edward L. Nichols	1
Thomas D. Lockwood	10	Lewis B. Stillwell	1
Charles P. Steinmetz	5	Joseph Wetzler	1
Harris J. Ryan	3	Alexander Jay Wurts	1

Total 341

FOR VICE-PRESIDENTS.

Total Number of Votes Cast 1018

William Stanley	321	Stephen D. Field	2
Robert B. Owens	306	William D. Weaver	2
Cary T. Hutchinson	260	J. J. Carty	1
Carl Hering	35	Gano S. Dunn	1
Charles F. Scott	34	S. Dana Greene	1
C. O. Mailloux	8	Elisha Gray	1
M. I. Pupin	6	James Hamblet	1
William A. Anthony	5	Angus S. Hibbard	1
Bion J. Arnold	4	Charles R. Huntley	1
Louis Bell	3	Dugald C. Jackson	1
Charles E. Emery	3	Thomas D. Lockwood	1
Francis W. Jones	3	Edward L. Nichols	1
F. A. Pickernell	3	F. A C. Perrine	1
Lewis B. Stillwell	3	Frank J. Sprague	1
Frederick Bedell	2	Nikola Tesla	1
Charles R. Cross	2	Herbert Laws Webb	1
Charles Cuttriss	2	Joseph Wetzler	1

Total 1019

FOR MANAGERS.

Total Number of Votes Cast 1357

Charles P. Steinmetz	324	Samuel Insull	3
Samuel Sheldon	318	William Maver, Jr.	3
Herbert Lloyd	316	M. I. Pupin	3
George F. Sever	311	Joseph Wetzler	3
William J. Hammer	7	Elmer G. Willyoung	3
C. O. Mailloux	4	Louis B. Marks	3
Harris J. Ryan	4	Ralph D. Mershon	2
William D. Weaver	4	Max Osterberg	2

Robert B. Owens	2	Reginald A. Fessenden	1
Wm. Lispenard Robb	2	William H. Freedman	1
E. P. Roberts	2	Caryl D. Haskins	1
Albert L. Rohrer	2	Edward E. Higgins	1
Nikola Tesla	2	Dugald C. Jackson	1
F. N. Waterman	2	A. A. Knudson	1
Norman W. Storer	2	Philip A. Lange	1
Frederick Bedell	2	Thomas D. Lockwood	1
Henry S. Carhart	2	T. Commerford Martin	1
Arthur V. Abbott	1	Richard H. Pierce	1
William S. Barstow	1	E. Wilbur Rice, Jr.	1
Edward D. Brown	1	Howard S. Rodgers	1
J. Stanford Brown	1	Frank Stuart Smith	1
G. Herbert Condict	1	Frank J. Sprague	1
Francis B. Crocker	1	Lewis B. Stillwell	1
Charles Cuttriss	1	Wilbur M. Stine	1
Wm. C. L. Eglin	1	Charles F. Uebelacker	1
Louis W. Emerick	1	H. Fleetwood Albright	1
Charles E. Emery	1	Alexander J. Wurts	1

Total....................1357

FOR SECRETARY.

Total Number of Votes Cast........339

Ralph W. Pope............... 338 | James Hamblet................ 1

Total....................339

FOR TREASURER.

Total Number of Votes Cast. 338

George A. Hamilton............338 |

Total................. ..338

The total number of voting envelopes handed to the tellers by the Secretary, was 370. Of these there were 20 which did not bear the address of the sender, and were therefore rejected without opening, according to the established rule. There were furthermore four members who had duplicated their votes, and the tellers in each case rejected without opening, the envelope bearing the earlier date, in accordance with a ruling of the President. This left 346 envelopes to be opened.

Among the contained ballots were two endorsed with the sender's name, which were forthwith rejected in accordance with a ruling of the President. The remaining 344 ballots were counted with the foregoing result.

Respectfully submitted.

TOWNSEND WOLCOTT,
J. P. WINTRINGHAM,
Tellers.

The Proxy Committee reported that 151 proxies had been presented in the names of the following members :

R. W. Pope	122
C. T. Hutchinson	20
C. P. Steinmetz	5
Gano S. Dunn	1
James Hamblet	1
Samuel Sheldon	1
C. P. Steinmetz	1
Total	151

At 10:35 P. M. the meeting adjourned.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

FIFTEENTH GENERAL MEETING.

OMAHA, NEBRASKA,
June 27, 28, 29 and 30, 1898.

The meeting was called to order by President A. E. Kennelly on Monday, June 27th, at 9:45 A. M.

THE PRESIDENT:—Before we open our regular proceedings, I have the pleasure of introducing to this INSTITUTE Acting Mayor Bingham, of this city. He informs me that Mayor Moores is unable to be with us, and in his place Mr. Bingham will be so kind as to say a few words to us.

MR. BINGHAM:—Mr. President and Gentlemen:—Our city charter provides that during the absence of the Mayor from the city, the President of the City Council shall perform the functions of the Mayor's office. Mayor Moores was obliged to leave the city on Saturday, and it is therefore my privilege and duty as Acting Mayor to extend to the members of your distinguished body a cordial welcome to the city of Omaha. The people of the west, like those of the south, have a reputation for hospitality, and I assure you that the brand dispensed in Omaha is the best in the market, and that the supply is unlimited.

We welcome you to the State of Nebraska—a wonderful State. Could you traverse our rich prairies and see our happy people, with their luxuriant crops and sleek herds and attractive homes, you would be amazed if you have hitherto had the impression that Nebraska is a State where drouth, hot winds, cyclones and blizzards, regularly follow each other with the changing seasons. Last year Nebraska acknowledged no State her superior for fertility and productiveness of soil, and many of you would be astonished to see the multitude of corn cribs and wheat granaries which line the railroad tracks throughout the state filled, even at this season of the year.

We welcome you also to our city. We are proud of its industrial and commercial supremacy in this central trans-Mississippi region. We are proud of our city because of the character of her citizens, to whose liberality, skill, push and energy the great Trans-Mississippi and International Exposition bears tribute. We are proud of our schools, proud of our public buildings. We are proud to welcome you, gentlemen, because you represent the progressive spirit of our times. This has been called the "Age of Electricity;" and certainly no other description could better characterize the progress of the last half century, so much of it due to the changes wrought by the use of electricity. Gentlemen, as we think of the wonders you have wrought in the past, we have come to expect great things from you, and we are prepared to accept, with scarcely a look of surprise, the great discoveries in the field of electricity which we know you will bring to us in the next decade. And now, gentlemen, in order to more effectively convince you of the welcome which Omaha and her citizens extend to you, I present you with these keys of the city, and express the hope that your visit in Omaha may be a pleasant one.

THE PRESIDENT:—I think our INSTITUTE may be proud of these insignia presented to us by his honor, the Mayor. We can heartily assure him of our intention to thoroughly enjoy the many advantages and pleasures which have so kindly been extended to us.

We intend to see and thoroughly enjoy the Trans-Mississippi Exposition at Omaha, and we have the honor of the presence of Mr. Wattles, who is President of that institution, and if he will favor us with a few remarks, we will be obliged to him.

MR. WATTLES:—Mr. President, I have been in the management of the Trans-Mississippi and International Exposition, and as such manager I take pleasure in extending to you a most hearty welcome to this city at this particular time. As you know, we have one of the largest expositions that has ever been held in the world, in progress here within the limits of the city of Omaha at this time. We have an electrical display on these grounds which I think you will admit stands perhaps as the master-piece of electric lighting effects of any that has ever been produced. I extend to you a hearty and cordial invitation to visit the grounds frequently and observe what has been wrought out there as the result of skill and genius in the great field of electricity during the past few years.

THE PRESIDENT:—Not only have we received the keys to the city from Mr. Bingham, but we have received the keys to the Exposition from Mr. Wattles. I am sure we shall all appreciate these kindnesses most heartily.

We have with us a gentleman who has been largely identified with the electrical matters, as well as with other matters in Omaha, and who is an electrician of long standing. I allude to Mr. E. Rosewater. We shall be very pleased to hear from him.

MR. ROSEWATER:—Mr. President, forty years ago this year I entered upon my apprenticeship in the electrical science, if such it might be called. During something like thirteen years I don't remember of having lost more than five or six days in the labor connected with telegraphy. I remember that while stationed in northern Alabama in the year '59 I was so anxious to perfect myself in the art of telegraphy or whatever there was in electrical science that I wrote a letter to Professor Morse asking him for advice, and I received an autograph letter of something like four pages, which I regret very much was lost in the war while in the neighborhood of Manassas during the year 1862, while I was campaigning with Hooker. Prof. Morse wrote me there were no books and nothing in the way of printed literature that would be available to instruct me, or to suggest even what studies I might enter upon in order to perfect myself in the electrical science, but he advised me to observe the phenomena that occurred on the wires, and by observing it get that information that was in the reach of operators. In those days we could not "climb the ladder of office," but we had to climb telegraph poles very nearly every other day, because in that country the operator had as a part of his duties the business of keeping the line in repair, and very often he had that work to do in a temperature of 120 in the sun or 105 or 106 in the shade, and he had to carry his climbers and insulators on his back and walk ten or fifteen miles and climb ten or twelve poles, and making observations in those days and under those conditions was not always as agreeable as it might have been. I remember once in middle Tennessee I was ordered to repair a line that had been broken. In those days the wires were so arranged that they would slip through the insulators, and spring away from the pole two or three hundred yards or half a mile because they were not fastened, and I had to hire a man to assist me. Although the sky was clear we were both knocked down by a terrific discharge of electricity thirty miles away. Those were the kind of observations that impressed themselves very strongly on me. I want to state incidentally that perhaps I was, in the telegraph service, the first person that transmitted dispatches over a wire without breaking the circuit, and it is perhaps an incident that may be interesting. I was in West Virginia and was ordered from New Creek into the Shenandoah Valley. I left Moorefield and I had to communicate with the other end of the line. I did not dare to cut the line, and I had nothing with me but a small piece of wire and a pocket instrument, and knowing that the operator was at the other end of the line, I just threw my copper wire over the main line and used my pocket instrument to the ground. In that way I got in communication with one end of the line without cutting the line at all. When I came to Omaha I assumed the office of Manager of the Western Union. Mr. Hibbard was Superintendent there and he insisted that the thing could not be done. I insisted that it could, and eventually I had the opportunity of testing it again. There was a flood in the Platte River, and when we arrived we found the wire in the water. There were no poles, but high cottonwood trees on each side. We pulled the wire out, and as we were within ten miles of the battery we were very badly shocked, and it was impossible to hold the wire. The repairer said that he couldn't handle the wire and must cut it. I said "No; they must take the battery off." I grounded the wire and said "take this battery off." I suppose the instruments on the table almost jumped off when we grounded the wire, but the operators took the battery off, as we suggested, and we repaired the line without having to cut the wire. Some year or two later, I think it was, Stearns said, and I could account for it a great deal easier and more readily than some others, that messages could travel in opposite directions over the same wire at the same time. Telegraphy has taken a tremendous jump since that time, and electricity has gone far beyond me.

Just before I came west I had a conference with Prof. Henry, of the Smithsonian Institution, and he asked me to report from time to time such meteorological observations as would be of special interest. I think I was the first person that served under the government in keeping the record of the weather. I kept the books at Omaha for two years. The records show the temperature and direction of the wind, etc., at Omaha, Julesburg, Fort Bridges, Fort Laramie, Salt Lake City and numerous other places. Those records were all sent to Prof. Henry. They were all important, but there is one in particular that I would like to call attention to, as I think it is very interesting. It was in the winter of 1864 during a blizzard when the temperature was down to 20 degrees below zero that the operators were obliged to take the batteries off, and I sent messages both sides of Columbus without any battery, but by the atmospheric electricity. I did not know what the cause might be, but I thought it might be due to an aurora. I wrote to Prof. Henry in regard to what had happened, and he wrote back that it was caused by the small, fine particles of snow drifting through the air from the west to the east over a long distance of wire, and that was the cause of all the trouble—and there is no doubt that Prof. Henry was correct. I have drifted away from the electrical field and have not kept pace with its progress, although in 1891 I went abroad and investigated some of the Postal Telegraphs of the world. I went to London, Liverpool, Manchester, Birmingham, Paris, Prague, Berlin, Hamburg and all the large cities of Europe, and made a very thorough investigation of the methods in use there.

I appreciate very highly the compliment you have paid me in calling me before a convention of this kind, and I hope we will meet often during the progress of your deliberations. I hope you will take the time necessary to see Omaha and get a favorable impression of it, not only of the Exposition, but of the city—a city in which I have lived for 34 years.

The regular business of the meeting was then taken up, beginning with the Inaugural Address of the President, as follows:

Inaugural Address by the President at the 15th General Meeting of the American Institute of Electrical Engineers, Omaha, June 27th, 1898.

THE PRESENT STATUS OF ELECTRICAL ENGINEERING.

BY A. E. KENNELLY.

While mechanical engineering may be said to have an antiquity coeval with civilization, its latest offshoot, electrical engineering, only came into existence with the advent of the electric telegraph some 60 years ago. For the greater part of this time electrical development was confined to the telegraphic industry, but with the extended introduction of the arc and incandescent lamps, the utilization of the magnetic properties of iron and steel made rapid progress in dynamo construction, so that the magnetic properties of steel now play almost as important a part in the advance of civilization as do their mechanical properties.

By far the greater proportion of electric development has come within the last decade and a half. Looking back from the Trans-Mississippi Exposition at Omaha of to-day to the International Electrical Exhibition of Philadelphia in 1884, the birthplace of the American Institute of Electrical Engineers, it is doubtful whether outside of telegraphy and telephony there was at that time in the United States a total investment of $1,000,000 in electrical applications. The words ammeter and voltmeter were just commencing to be generally recognized, and of electric traction there was none. At the present time the capitalization in electrical applications in the United States is estimated at about $1,900,000,000.

In 1884 a 50 k. w. dynamo was considered a large machine, while a 100 k. w. Edison steam dynamo was justly called a "Jumbo." At the present time the largest size of generator built or building is of 4,600 k. w. capacity. The price of dynamos in 1882 was about 20 cents per watt of out-put, while dynamos of similar running speed in comparatively small sizes without switchboards, now cost about two cents per watt. The great reduction in price represents the aggregated result of the very large amount of labor devoted to this branch of engineering in the last 15 years.

It is interesting to notice that the efficiencies of continuous-current dynamos have not made any marked nominal advance since the birth of the INSTITUTE, though their output per unit of mass has considerably increased. Thus the 50 K. W. dynamo tested at the Philadelphia Exhibition is stated to have had an efficiency of approximately 92%, and this would be considered a satisfactory performance in that size of machine to-day. But, where the output then was only six watts per pound of net weight (13.2 watts per kilo) the output of a machine of similar rating and speed to-day would be about 10 watts per pound (22 watts per kilo.) In other words, the efficiencies of the best dynamos of 1884 were already so good that it has not paid, at existing costs of power, to markedly improve them, and such improvements in material and design as have since been effected have enabled manufacturers to increase the rating or yield, and, therefore, the cheapness of the machines. It seems probable, moreover, that this will continue to be the direction of future progress. We scarcely can desire more efficient machines than the best we have now, but we shall always desire cheaper and more powerful machines, and shall welcome any improvements which lead to them.

Another evidence of the development in dynamo machinery is their improved appearance. Formerly, the only claim possessed by such apparatus was utility. More recently, grace, the expression of unconscious power, has supervened, and the modern dynamo is often pleasing to look upon as well as useful to operate.

The cost of generating a kilowatt-hour of electric energy from steam for electric lighting, appears to have been at least 7.5 cents at bus-bars in 1884. At the present time the cost of delivering a kilowatt-hour to large street railway systems from steam, is only about one cent, and the power-house operating costs are reported in some cases as low as half a cent. In municipal electric-lighting systems supplied at low pressure from steam central stations and hampered by relatively heavy distributing expenses, the retail price of the kilowatt-hour varies from 20 to about 4½ cents, according to the locality and quantity consumed. Niagara power is now sold to consumers in Buffalo at rates varying, according to the amount delivered, from two cents to slightly less than two-thirds of a cent per K. W. hour delivered.

The price of 16 candle-power incandescent lamp 16 years ago was about $1.00. Now it is about 18 cents. The best lamps at that time, under laboratory conditions, gave about 0.28 mean horizontal normal British candle-power per watt, and under commercial conditions about 0.20. The highest pressure for which they could then be obtained was about 110 volts. At the present time lamps are obtainable giving normally 0.4 mean horizontal British candles per watt, while under commercial conditions the average lamp normally develops about 0.25 candle per watt. They can also be obtained (at 0.25 candle per watt) for pressures up to 240 volts, and are frequently installed on 220-volt mains.

Arc lamps were already so far advanced in 1884, that comparatively little improvement in their effectiveness has taken place, the gain having been made in economy of operation. Thus, the carbons which cost at that time about six cents apiece, now cost about two cents apiece. The enclosed arc lamp has of recent years become popular owing to its diffused light and a carbon life of from 100 to 150 hours.

It has been estimated that about $600,000,000 has been invested up to the present time in electric lighting stations and plants in the United States.

The best storage cells tested at the Philadelphia Exhibition of 1884 gave a yield, under laboratory conditions, of 3.425 watt-hours per pound of electrodes (7.55 watt-hours per kilo) with an energy efficiency of 69.45 per cent. when discharged at the mean current density of 12.42 amperes per square foot of negative plate surface (1.34 amperes per square decimetre); while the deterioration was comparatively rapid. At the present time storage cells are in use giving under laboratory conditions, a yield of from 5 to 6 watt-hours per pound of charged cell (11.0 to 13.23 watt-hours per kilo), with an energy efficiency of about 85 per cent. when discharged at a current density of 4.8 amperes per square foot of negative plate surface (0.52 amperes per square decimetre.) There are now storage batteries installed in the United States to the aggregate capacity of about 56,000 kilowatt-hours. The largest installation has 166 cells, weighs 500 short tons and has an eight-hour discharge capacity of 22,400 ampere-hours, or 3136 K. W.-hours at 140 volts pressure.

A very great development has taken place in the direction of electric traction, by virtue of which, the horse car, once so well nigh ubiquitous in the city streets, has almost entirely disappeared, while electric locomotives of 1,500 H. P. have even made their appearance on steam railroad tracks. The introduction of soft cast steel has been very advantageous to the electric motor, enabling its output to be increased from five watts per pound of net weight in 1884, (11 watts per kilo) to about 14 watts per pound (30.9 watts per kilo) in street-car motors, at the present time. It is estimated that there are, to-day, in the United States, about 14,000 miles of electric railroad, with a nominal capital of about one billion dollars, and employing about 170,000 men.

The electric transmission of the power of falling water is a branch of engineering that has come into service since 1884, and is making rapid strides, owing to the recent successful employment of high voltages and multi-phase alternating currents. It has been estimated that about 150,000 K. W. of this class of machinery is installed in the North American continent, commercially transmitting power to various distances up to 85 miles, at various pressures up to 40,000 volts.

The alternating-current induction motor has become very popular in recent years, mainly owing to its powerful starting torque and its freedom from commutator and brushes. A burned-out armature, the perpetual source of dread in motor operations of days gone by, is practically unknown in this type of machine, even when put to severe service. Indeed its depreciation under fair conditions appears to be as low as in any class of rotating machinery.

The alternating-current transformer has been correspondingly improved, developing in large sizes, an efficiency of about 98.5 per cent., and an output, when cooled by external power, of about 100 watts per pound of weight (220 watts per kilo.)

The principal engineering value of electricity to-day, lies in its adaptation to the transmission of power, through mills or cities, or from some locality where power is cheap to another where it is dear. A steel rope, by its bodily motion, can transmit, with appreciable friction and depreciation, some hundreds of kilowatts to a distance of some thousands of feet. A bare quiescent copper rope, half an inch in diameter, and supported on poles, can, by maintaining an effective potential of 10,000 volts, by the motion of electric waves over its surface, transmit say 2,500 K. W. with an energy loss of two-thirds per cent. per mile (0.4 per cent. per kilometer), and with practically no depreciation except to the poles and supports.

The use of high pressures has thus become more frequent during the last few years. Alternating-current generators are now made to supply 10,000 volts at their terminals, and insulation-testing sets have been made for producing alternating pressures up to 100,000 volts effective.

The application of electric power to domestic use and household comforts, irrespective of illumination, has made steady progress. In the large cities, the fan-motor day load of summer is in the aggregate a perceptible quantity, while electric ranges and heaters on a small scale have found favor through their convenience.

In telegraphy, comparatively little change has recently taken place, beyond the substitution of the dynamo or dynamotor for the voltaic battery, and of copper line-wire with some five ohms per mile, for iron wire with some 13 ohms per mile. About one million miles of telegraph wire are now strung on some 200,000 miles of pole line in the United States, connecting about 25,000 offices and working a capitalization of about one hundred and fifty millions of dollars.

In the United States, the uniformity of the closed circuit Morse system simplex, duplex or quadruplex, is only varied by an occasional Wheatstone set. This crystallization of methods is not due to any lack of invention, or capability of improvement in signaling speed, but rather to the apparently settled belief that the present systems are the most economical under existing conditions of traffic. In long submarine telegraphy, the pressure of increasing traffic has made itself more distinctly felt, and automatic curb-senders have, to some extent, been introduced, but the physical difficulties in the way of attaining high speeds have as yet been obviated only in part by an increased expenditure in copper and gutta-percha, to obtain a diminished conductor resistance per mile. Wireless telegraphy has entered its experimental stage, and bids fair to enter practical service in the future, at least within a limited range. Its public use thus far in the United States seems to have been limited to blowing up at stated intervals, in the recent New York Exhibition, miniature models of the "Maine," at a distance of some 25 metres from the oscillator.

In telephony, the most notable improvement in recent years has been the general substitution of metallic circuits for ground return circuits, with great advantage to the convenience and effectiveness of the traffic. At the present time conversation is carried on commercially up to a distance of 1,800 miles, and quite frequently at distances of 1,500 miles. There are at the present time in the United States about 1,000,000 telephones connected with the telephone service of the country, employing a capitalization of about 100,000,000 of dollars, 400,000 stations and about 900,000 miles of wire. Every day about 17,000 employees make on the average more than 3,000,000 of connections. About 300,000 miles, or nearly one-third of the total length of telephone wires have, within the last few years, been made up into aerial and subterranean cables within city limits, owing to the reduction of the electrostatic capacity effected in such cabled wires to less than one-twelfth of a microfarad per mile of single wire.

At no time has a useful discovery or improvement had more chance of welcome or application than at present. As an example, the case of Roentgen rays may be cited. Professor Roentgen's celebrated paper announcing the discovery of X-rays was read in Wurzburg in December, 1895, and the particulars were not known in the United States until early in 1896. In the same year (December, 1896) radiographs were accepted as legal evidence in a United States District Court.

A considerable development has occurred in electro-thermic and electrolytic processes. More than 4,000 kilowatts of Niagara power are now employed in such processes. Among electrochemical processes are the electrolytic refining of copper to the extent of about 150,000 tons annually, the production of aluminium, the production of sodium and alkalis and the treatment of ores. Among electro-thermic processes are the production of the carbides of silicon and calcium in steadily increasing quantities.

In electrotechnical theory considerable advance has been made of recent years, particularly in the study of alternating currents. Accompanying the expansion of knowledge in the various branches there is a tendency to combine and unite them into one general theory. Thus, while the early dynamos generated a low-tension electricity which was once regarded as something so dissimilar to high tension electricity as to require separate treatment and classification, to-day the high-tensions derived from alternators through step-up transformers, so far invade the territory of so-called frictional electricity that a dividing line between the two classes can no longer be maintained. Similarly telephony and telegraphy are coming to be regarded as sub-classes of alternating current power transmission, while electricity and magnetism cannot properly be studied apart.

Although a large amount of electrical work is done in physical laboratories in the United States, a comparatively small amount of the results of this work becomes available to the science or art of electrical engineering. Each year sees more than a hundred students engaged in experimental thesis work after a laborious training and preparation for several years in the technical college. Many of these men have the time and facilities to do the best experimental work of their lives under the guidance of their instructors. Some of the men display aptitude and interest in some special line of research in which they would be best left untrammeled, but in most cases the experimental work under co-operative guidance could accomplish a great deal for the knowledge and progress of our branch of applied science. There are numerous questions concerning the various electromagnetic properties of matter and of the ether that are of great and growing importance, and there are numerous scientific subjects of immediate practical importance that it is necessary to measure and observe, so that by uniting the available experimental resources of the various colleges in this country under a common leadership, in sympathy with the college instructors, the results which now largely fill thesis books lying on neglected shelves might be incorporated into permanent results for the general advancement of our profession. The plan would involve practically no expenditure beyond the voluntary efforts of those upon whom the duty devolved of formulating and dividing the subjects of research, and classifying or comparing the results attained. Such a system of co-operation among the students through their instructors would economize a large amount of the most skilled technical labor, and accelerate progress in all branches of inquiry, application, and industry. No better work could be undertaken by our INSTITUTE than the fostering of such an organization.

The technical progress of a profession like ours is shown by the precision of which it is capable. A loose nomenclature begets looseness of observation and description, and is inconsistent with a high degree of development in a science that quickens the footsteps of every human industry. The tendency of our machinery and definitions to become standardized is apparent in the impulse which has led the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS to appoint a Committee on Standardization, the preliminary report of which is to-day laid before this INSTITUTE for consideration.

In connection with standardization it is important to observe that there has been of recent years a tendency to depart from the regular standards of dynamo machinery built by the manufacturers, in favor of special machinery of independent design. To a limited extent this is, of course, necessary under the pressure of changing methods and conditions, but there is reason to believe that much more special machinery is built than necessity can warrant. Not only is the special machinery thus ordered or specified considerably more costly than standard machinery, but the tendency, by interfering with the natural shop methods of standardizing and cheapening production, prevents regular consumers from purchasing standard machinery at as low rates as would otherwise be possible. When we consider that the industrial radius of application of electricity mainly depends upon the first cost of the apparatus it employs, it needs no homily to drive home the conviction that the unnecessary introduction of special machinery is a puncture in the tire of progress.

Our INSTITUTE may well take pride in the share which it has taken in the electric progress of the fourteen years which have elapsed since its inception. It now numbers 1100 members. Its purpose is to aid all who seek to acquaint themselves with this branch of science and art, and to set the stepping stones of progress in the sands of time for the advance of the industrial applications of electricity.

OLIVER BLACKBURN SHALLENBERGER,

A Memorial.

BY CHARLES A. TERRY.

Oliver Blackburn Shallenberger was born at Rochester, Pennsylvania, May 7th, 1860. His father, Dr. A. T. Shallenberger, is one of the leading physicians of western Pennsylvania, and a brother of the Hon. W. S. Shallenberger, formerly a member of Congress and now Second Assistant Postmaster General. Upon his mother's side he descended from the Bonbright family of Youngstown, Penna.

He received his early education at the public schools of Rochester, and at Beaver College in the neighboring City of Beaver. In 1877 he entered the Naval Academy at Annapolis, as cadet engineer. Out of the one hundred and twenty-six candidates examined, twenty-five were admitted and young Shallenberger entered at the head of his class. He held this position throughout the year. The work of his second and third years was seriously interfered with, first by an accident resulting in a broken arm and a dislocated wrist, and afterward by impaired eye-sight which compelled him to abandon night study. Notwithstanding these disabilities, he held third position in his class at the end of his course.

The department of physics at Annapolis occupied a prominent position in the curriculum at the time of Mr. Shallenberger's entrance, and particular attention was given to electricity. Mr. Shallenberger found in this line of work a field peculiarly congenial to his tastes, and was enabled to indulge his natural inclinations toward original experimental investigations. The systematic training and thorough knowledge of the fundamental principles of physics which he was thus able to acquire, formed the basis of his subsequent careful work, and enabled him to readily and accurately shape the directions of his investigations along lines in which he was always surprisingly free from erroneous conclusions and those deviations and vagaries which are characteristic of many inventive minds. After completing the three years' course at Annapolis, he took the customary two years' cruise upon a government vessel. He was assigned to the U. S. flag-ship "Lancaster," and the greater portion of the time was spent in the Mediterranean. The most notable experience of these two years was that of witnessing the magnificent spectacle of the bombardment of Alexandria. The vivid pictures of different scenes of this event which Mr. Shallenberger's clear, concise style and remarkable command of language enabled him to give, were always full of fascinating interest to his friends. Among his contemporaries at the Naval Academy were Mr. Frank J. Sprague, Dr. Louis Duncan, Mr. W. F. C. Hasson, Mr. Gilbert Wilkes, and several others whose names are prominent among electricians.

In 1883 he returned to the United States, and in 1884 resigned from the naval service and thereafter devoted his entire attention to the science of electricity. The Union Switch and Signal Company, of Pittsburg, under the management of Mr. George Westinghouse, was at that time organizing an electric light department, and Mr. Shallenberger became associated with that work. His genius and executive ability were at once recognized and he was selected to take charge of the experiments made the following summer and fall with the Gaulard and Gibbs alternating current apparatus which Mr. Westinghouse imported from Europe. During this period Mr. Shallenberger was associated with Mr. William Stanley and Mr. Reginald Belfield in the commercial development of the alternating current system. The results of the investigations made by the Union Switch and Signal Company led Mr. Westinghouse to organize the Westinghouse Electric Company and Mr. Shallenberger was appointed Chief Electrician of that company and later of its successor, the Westinghouse Electric and Manufacturing Company. He was elected an associate member of the INSTITUTE September 7th, 1888, and was transferred to membership December 4th, 1888.

In 1889 he went abroad and spent a considerable time in visiting the central stations in many of the larger European cities. In 1891 failing health compelled him to resign his position as Chief Electrician, but the Westinghouse company, unwilling to part with his services, retained him as Consulting Electrician. The succeeding winters he was compelled to spend in Colorado, but the summer months were spent at his home in Rochester, where he continued his work at a well equipped laboratory near his residence.

In 1897 he organized the Colorado Electric Power Company, of which he was President at the time of his death. He returned to Colorado in October of 1897, accompanied by his wife, Mary Woolslair Shallenberger, whom he married November 27, 1889, and their two children, a son and a daughter. His strength gradually waned, and during the evening of January 23rd, 1898, he passed peacefully from among us.

Twenty-four years devoted to education, and fourteen years spent in giving to the world the fruits of his splendid intellect, span the brief period of his life, but each year of that short life witnessed the cultivation of a most lovable character, the development of a masterly mind, and lasting benefits to his fellowmen.

It would be interesting, indeed, to review many of Mr. Shallenberger's important contributions to the electrical art and to trace back to his engineering skill many of the essential features which are utilized in the modern systems of electrical distribution. He invented the street lighting system in which each of a series of incandescent lamps is shunted by a reactive coil having its winding so proportioned to the mass of iron in its core that upon the interruption of the current through any lamp, a normal current is allowed to flow through the corresponding coil to the remaining lamps by reason of the consequent high magnetic saturation of its core. The construction of converters with primary and secondary coils separately wound and insulated was originated by him. He also was the first, in this country at least, to connect alternating current generators in parallel circuit, and he devised ingenious methods and apparatus for that purpose. The compensating indicators for showing at the central station the condition of the consumption circuit were worked out by him. His latest work was in producing a series of alternating current recording and indicating wattmeters for accurately measuring the energy consumed upon inductive as well as non-inductive circuits, and compensating for variations in temperature and rates of alternation. But of all his inventions, the development of the current meter bearing his name is surrounded with the greatest interest, not alone because of its intrinsic value and importance, but because it illustrates the character and mental aptitude of the man. He was original in his conceptions, comprehensive in his grasp of ideas, conscientiously thorough in developing them, accurate in his conclusions, and complete in his final expression; these characteristics were abundantly evident in his development of the meter. While testing an experimental arc lamp upon an alternating current circuit, his attention was attracted by the rotation of a small spiral spring, which, dislodged from its position in the lamp, had fallen upon the brass head of the magnet-spool adjacent to a projecting core of iron wires. The motion was so slow as to be scarcely perceptible, but it did not escape his quick observation. He realized at once that he was in the presence of a new phenomenon. All his energies were immediately devoted to ascertaining the cause. Experiment followed experiment in rapid succession. Before he left the laboratory that night he developed from this accidental suggestion the complete conception of the alternating current meter, an object for which he, as well as many others, had for many months sought in vain. He pursued his further experiments with such zeal and good judgment that within a month he had produced a complete working meter, in essentially the same form that it is now manufactured after nearly ten years of extended use.

It is a curious but well recognized fact that important inventions and brilliant discoveries are often independently made by different people in widely separated localities, and the history of the production of the rotary field motor, an essential part of the Shallenberger meter, contains a striking instance of this phenomenon. While Mr. Shallenberger was producing his meter in Pittsburg, Mr. Tesla in New York was preparing to make public the wonderful discoveries which he had made in alternating current motors. Professor Ferraris, at Turin, contemplating with the delight of a profound scientist the beauty of a mathematical theory successfully demonstrated by the workings of physical apparatus, had prepared a paper descriptive of the theory of operation of a small motor which he had previously constructed, and suggesting its applicability to electric meters. Mr. Shallenberger's discovery was made during the week ending April 20th, 1888. Mr. Tesla presented to this INSTITUTE his memorable paper regarding his work on the evening of May 1st, 1888, the same day that his patents were issued. Professor Ferraris' article appeared in a journal which, while bearing a somewhat earlier nominal date, was actually published during either the last week of April or the early part of May, The results of the work of each of these three brilliant inventors was characteristic of their respective mental attributes, and while neither might have arrived at the special utilization of the others, they independently discovered the fundamental theory of the rotating field, one through an inventor's intuitive process of reasoning, another through pure mathematical calculations, and the third through a quick perception and intelligent appreciation of the presence of an unusual phenomenon.

The history of the first decade of the Westinghouse company's existence is full of the personality of Shallenberger. His ability to fashion apparatus in its simplest, most efficient form, was one of his prominent characteristics. The words of Prof. Tyndall, used in reference to another inventor, are peculiarly applicable to Mr. Shallenberger: "He had an inventor's power, and an inventor's delight in its exercise. Such minds resemble a liquid on the point of crystallization. Stirred by a hint, crystals of constructive thought immediately shoot through them. He had the penetration to seize the relationship of facts and principles, and the art to reduce them to novel and concrete combinations."

His lovable character, strong Christian manliness and capacity for warm friendship, endeared him to those who knew him best. The many who knew him by his works only, will gain some conception of the value of these qualities through the letters from some of his friends which it is my privilege to present with this brief tribute to his memory:

From LEONARD E. CURTIS.

Mr. Shallenberger was one of the most lovable men I ever knew. He had a singularly sweet and cheerful temper, a rare unselfishness and a sincere honesty of character that made friends of all who knew him. I do not think he ever had an enemy. His unfailing courtesy, his thoughtful consideration for the rights and feelings of others, in small things as well as great, his keen sense of humor, and a certain playfulness of imagination and quaintness of expression in his ordinary intercourse with his friends and associates, made him a most delightful companion for us who knew him well. His amiability did not, as is often the case, come from weakness, for he was a man of strong convictions, and when any question of right and wrong was involved, nothing could divert him from the strict line of duty. His cheerfulness of temper came largely from an abiding faith that "somehow good shall be the final end of all," and also in large measure, I think, from a certain clearsightedness as to the facts of his environment and an uncomplaining acquiesence in what was inevitable.

Others will probably be able to speak from more direct knowledge with regard to his work as an engineer and as one of the executive officers of a great industrial organization, but I had an opportunity to see a good deal of his work as an expert and as an inventor. We worked together in a good many patent cases, some of which were very intricate and difficult, and I soon came to regard him as the strongest and most reliable electrical expert that I knew. His knowledge of the physical laws relating to electricity and magnetism was very thorough and practical, his powers of observation were acute and highly trained, he was an ingenious and careful experimenter, and he was, above all, a singularly clear thinker and close reasoner. In consultation he was especially helpful. Plausible fallacies and untenable positions that had at first more or less attraction for most of us did not detain his attention long. His mind seemed instinctively to reject any proposition that led to an illogical conclusion, and he did not take a position until he had worked out all the logical consequences of it. He was a very strong witness. His language was simple and direct, but clear and forcible, because he was a clear thinker. On cross-examination he never gave me any anxiety. He might amplify or explain on cross-examination the views he had expressed in his direct testimony, but he had no occasion to modify them because he had already thought the matter out fully and told the truth as he understood it.

Although he was severely practical in his work, he had a vivid imagination, and was fond of speculative discussion when more serious work was not pressing. I have spent many delightful hours with him in the intervals of our work, and later when we both had a good deal of leisure here, in discussing the unsolved problems of science and the greater problems of the supernatural world. It is one of the great sorrows of my life that there are to be no more such hours for me.

I have touched on a few points that especially impressed me in Shallenberger's character, but I feel that I can give no adequate expression to what he was to me and to others who were so fortunate as to know him well.

Colorado Springs, March 7th, 1898.

From Elihu Thomson.

Though it was not my fortune to meet Mr. Shallenberger frequently, I obtained at the outset a high appreciation of his fine character and genial disposition. To meet him was to admire and trust him. It is one of the great sorrows of life that such friends are so soon taken from us.

Mr Shallenberger's electrical work is so well known and so highly valued as to need no praise from me. He held a high place among electrical engineers. The discovery of the principles of alternating current induction, upon which, in his hands, his beautiful induction meter and measuring instruments were founded, is sufficient evidence of his great ability and technical skill.

His work has left a lasting impression upon alternating current science and industry, and we cannot escape the conviction that had his life and health been spared he would have continued his successful work and would have won many fresh laurels.

Swampscott, Mass., March 8th, 1898.

From Frank J. Sprague.

Mr. Shallenberger's life and character, his abilities and accomplishments, merit special record, the more so because of his own gentleness and modesty. His old naval associates feel a special pride in his work, much of which has become standard, and had his life and health been spared, it would have been still more for the lasting benefit of electrical science.

His friends will long miss a good fellow and a loyal companion of most lovable character, especially endeared to them by the pathetic ending of his career. Among those friends, I am more than glad to have been one.

New York, March 17th, 1898.

From Nikola Tesla.

I am glad that your letter gives me an opportunity to express how deeply I have regretted the death of Shallenberger. The electro-technical profession has lost in him one of its most gifted members. Many a bright idea is recorded in his numerous patents, and much of his work is embodied in the splendid machinery which, during a number of years, he has helped to develop. Although stricken down in the prime of life, he leaves a brilliant record in the profession.

Shallenberger has also made a record as an original discoverer ; for, although at a later date, he independently observed some rotations in a magnetic field, his merit is all the greater, as he did not stop at a laboratory experiment, but quickly applied the principle practically and produced his beautiful measuring instruments.

Shall we content ourselves to merely honorably mention the name of a man who has done so much ? I will not presume to make a suggestion in my capacity as one of his co-workers, but Shallenberger was a friend whom I have liked and esteemed highly, and particularly in this quality I would feel very gratified to see his name more fitly commemorated.

New York, March 17th, 1898.

From William Stanley.

Oliver Shallenberger was a delightful man to know—frank, fearless and positive, he possessed in an eminent degree that clear-headedness which made him sure of every step in his scientific work.

When he first began his practical alternating current work there was little available information on the subject. No alternating machinery had been constructed in this country, and the laws governing alternating current phenomena were but vaguely understood. In fact, the machinery for the transmission and transformation of energy by alternating currents was devised and put in practical use before the laws governing such machinery had been digested by engineers. Into this chaotic condition of affairs Shallenberger threw his whole strength. He quickly separated the logical and useful information from the unscientific and uncertain ; he made clear and simple many vexing and misty problems, and he probably did more than any engineer of the time in perfecting the so-called alternating system.

But, while Shallenberger's value as an engineer was known to many who came in contact with him, it was the privilege of but comparatively few to know him as I knew him; to know his charming personality and his high character. And while his inventions and engineering work have created a prominent place for his name in the development of practical electricity, his personality created friendships which his untimely death can but cause his friends to cherish the more.

PITTSFIELD, MASS., March 12th, 1898.

From ALEXANDER JAY WURTS.

It was my good fortune to be associated with Mr. Shallenberger as far back as 1887. I soon learned with others to admire his clear mind and wonderfully good judgment, but it was not so much these characteristics, together with his great inventions and the rapid progress he made in the science of electricity, which attracted my attention—there is not such a great lack of brilliant men in the world—what drew me to him more than anything else was his beautifully refined character. It was a real pleasure to greet him after a week's absence. I shall never forget his generous hand shake and his always cheerful and pleasant "good mornings;" and he was just the same to all—everybody loved him.

I remember so well when Mr. Shallenberger first went to Colorado. It seemed as though the light and life of the laboratory had gone out; and as though we really could not get along without him. But now that he has gone from us, not to return, it is not so much his great inventions or his loss as a scientist that is talked about among his associates, but rather some phase of his character. The loss which we all feel is "O. B." Those who knew him will at once recognize what I mean and nothing else can possibly express it.

PITTSBURG, PA., March 9th, 1898.

From T. C. MARTIN.

The history of the alternating current in this country must always include Mr. Shallenberger's early work, for he not only did much to introduce the system for practical purposes, but was one of the first to address himself to the difficult problem of measuring that current. His success, in the beautiful instruments that bear his name, is a matter of record. It must not be forgotten that Mr. Shallenberger did his best work, in this direction, at a time when the alternating current was hardly known, harshly criticised and bitterly opposed; and hence he is entitled to double credit for the foresight and courage which led him to advocate its many solid claims to consideration.

Of Mr. Shallenberger personally, one can only speak in terms of admiration. He was a conspicuous member of that group of naval students who within the last fifteen years have made a deep mark on the electrical art in America; and he had a pleasant, breezy way that is associated in the popular mind with sea life. It was a pleasure to meet with him and talk with him. He not only was generous in his views but had insight into affairs and ability to express well defined opinions in a clear, incisive manner.

NEW YORK, March 16th, 1898.

From CHARLES F. SCOTT.

Mr. Shallenberger's simple, clear, straight-forward way of thinking, impresses me as his preeminent characteristic. His mind was capable and discriminating, and he possessed a remarkable facility for transferring his ideas into physical forms His best known work—that on alternating current meters, well illustrates his clearness and keenness of thought and the direct and elegant way in which he expressed his thoughts mechanically. The meter work especially exemplifies his refinement and delicacy in both thought and manipulation. There was usually but a single step from the matured idea to the practical commercial form. It is not often that a new piece of apparatus remains unchanged for any considerable time. This has been especially true in electrical apparatus during the past decade when revolution and evolution have been common ; but the original current meter was invented and developed and in the short period of a few months received a mechanical form which has been duplicated a hundred and thirty thousand times and is still being repeated daily with only minor changes. His recent work on alternating current measuring instruments shows at once a breadth of conception in taking a general survey of the theory of electrical instruments, and the minuteness and precision with which he cared for the minutest details.

It is difficult to realize now how truly work in the alternating current field a dozen years ago was pioneer work. But what was lacking in those early days in knowledge and experience, he made up in keen insight and generous common sense.

Upon meagre data, new types of apparatus, dynamos and transformers, measuring instruments and auxiliary apparatus, must be quickly designed and made ready for service. The success of that work contributed in no small measure to the subsequent extension and development of the alternating current system, and this success was due in no small measure to the clear insight, the sound judgment and the intelligent common sense of O. B. Shallenberger.

The symmetry of his character was a notable characteristic. In his theoretical study, in his method of experiment, in the apparatus which he produced, in his official relations with those under his direction, in his relations as personal friend and also in his home relations—there runs through all a consistent simplicity, integrity and sameness.

PITTSBURG, PA., March 13th, 1898.

From REGINALD BELFIELD.

I am very glad to have this opportunity of adding my tribute to the fine character and great ability of my dear old friend, O. B. Shallenberger, whom I have had the privilege of knowing intimately for over twelve years, and have therefore had very many opportunities of appreciating his worth.

From every point of view Shallenberger was one among a thousand ; he was a true friend, a great electrician, and altogether a type of manhood which is seldom seen. It is difficult, therefore, to confine oneself to any one of his particular attainments, as he was so many-sided that whether you consider his character, ability or work, the temptation is to stray away from that special subject, and contemplate them all.

Shallenberger, when first I knew him, was Electrician to the Union Switch and Signal Company of Pittsburg, Pa. Here, in the very early stages of electricity, his talents and inventive genius were most marked, his grasp of any new matter great, which, with his capacity for hard work and diligence, pointed him out as one of the most brilliant workers of the day in this subject. Even so early as this he had turned his attention to alternating current distribution—at that time quite in its infancy—and in the development of this system most of his later work has been devoted. All the earlier machines of the Westinghouse company, transformers, instruments, and the thousand and one other things which go to make up a system, were designed by him, and his fertile brain was never at a loss to work out new pieces of apparatus to overcome difficulties as soon as they presented themselves.

Despite the enormous amount of work which his position entailed, he was always experimenting, with most satisfactory results, as the Patent Office records amply testify, and the Westinghouse company has lost a most valuable and esteemed man by his early death.

Shallenberger was gifted with a very sound judgment, and he most fully considered all questions from every point before expressing an opinion. His experimental work was also directed with a clearness of perception, a full knowledge of the matter, and an exact idea of what he desired to obtain ; this enabled him to conserve his energies, and was the secret of the immense amount of work he was able to get through during his life. His grasp of a subject was very quick and thorough, and from a small experiment which to an ordinary observer would seem of little or no moment, he was often able to obtain results of great value.

LONDON, ENG., March 16th, 1898.

OBITUARY.

Charles Edward Emery, Ph.D. (associate member, June 26th, 1891, member, April 19th, 1892,) was born at Aurora, New York, on March 29th, 1838, and died in Brooklyn, on June 1st, 1898. He was a descendant of a branch of the Emery family that came from England to Newbury, Massachusetts, in 1635. He attended the Canandaigua Academy, and at the same time lost no opportunity to acquire information from independent sources, by which means he early became acquainted with practical engineering. A branch of the Erie Railroad terminated at Canandaigua, and one of the engineers on that road took D. K. Clark's work on the locomotive, in numbers, which young Emery borrowed and read in detail, and then after thoroughly mastering the contents, he explained it to the enginemen at night in the roundhouse. The enthusiastic spirit which prompted such a course of study, soon found an opportunity for the practical application of the information thus gained and carried the application to success. The engines on that division of the road had been running for over two years without repair, and the valves were working badly on account of lost motion. Young Emery recommended that the eccentrics be advanced to restore the lead, and the recommendation being adopted, he superintended the operation, school-boy as he was, while the gray-haired men pinched the engines along the track and reset the eccentrics as directed. He then ran one of the engines over the road, under the eye of the engineer, to try the effect of the new adjustment, which proved to be quite satisfactory. Incidentally it may be remarked that he was not strong enough to hook back for expansion, without assistance.

Another boyish exploit of our budding engineer, was the building of a steam engine with his own hands, and almost without tools. The majority of boys who have a natural liking for machinery, at some time during their youthful days, either build or attempt to build steam engines, and young Emery's engine and the process of construction thereof, bore many points of resemblance to the type form. There was the usual poverty of tools and material, and wealth of more or less ingenious makeshifts, but in one respect this engine was differentiated from the type form: it eventually ran with real steam, generated in its own boiler. The specifications of this remarkable engine were, so far as recorded, as follows. The fly-wheel spokes and connections were of wood, the cylinder was an old syringe made of type-metal or similar alloy; the cylinder ports were capped with an iron plate, which with the type-metal valve, was accurately laid out and finished, as our young engineer had advanced ideas in regard to valves and valve gear. The boiler was made from a length of stove-pipe, with wooden ends nailed in, and made tight by boiling bran inside, which in those days was the most approved method of stopping small leaks in steam boilers. The most remarkable thing about this engine however, was the construction of the valve gear. Young Emery was an engineer on his own account, and not a mere imitator. He designed for this engine, a valve gear in which the principal motion was given by a link turning on a fixed center, the lead being obtained independently from the cross-head. This device was long afterward brought out in Germany and became well known under the name of the Waelschaert valve gear. It was used in the heavy pushing locomotives in Belgium, in the Fairlie type of engines built by the Mason Locomotive works at Taunton, Massachusetts, and in some steamships by Bryce Douglass. Another model contained the germ of one of the radial valve gears now in use.

After leaving school Mr. Emery was for a short time employed in the drafting room of a railroad company, and afterwards in a country foundry and machine shop, where he helped in the foundry, ran the engine, operated iron and wood-working tools, made drawings of machinery or prepared cases for the patent office, as circumstances required. This was a course of training of great value to an engineer, and Mr. Emery made the most of his opportunity. He took a special course of study in the office of Marvin Porter, C. E.; next at the solicitation of friends he entered the law office of Hiram Metcalf, Esq., where he studied law for two years, with a view of becoming a patent lawyer, and at odd times busied himself as a land surveyor, and in making maps and plans of buildings.

The first shot at Sumter found him on a sick bed, but soon after he organized a military company which was, however, disbanded without having seen service, owing to the premature proclamation of President Lincoln that no more troops were needed. A little later Mr. Emery entered the Navy as an assistant engineer, and was on the steamer Richmond in the engagement at Fort Pickens, the capture of New Orleans, and the naval attacks of Vicksburg and Port Hudson. Some suggestions made by Assistant Engineer Emery as to experimental steam apparatus reached the ears of Engineer-in-Chief B. F. Isherwood, who ordered him to experimental duty at the Novelty Iron Works, New York, where he had unusual opportunities for several years. Mr. Emery resigned from the Navy on January 1st, 1869, and was engaged for a year in making experiments for the Novelty Iron Works in connection with the proposed manufacture of steam engines, and prepared the elaborate circular afterwards published in book form by the vice-president, W. P. Trowbridge, entitled "Condensing and Non-Condensing Engines."

Mr. Emery was engaged in the fall of 1869 as the general superintendent of the American Institute Fair, it being at the time arranged that he should go back to the Novelty Iron Works as general superintendent. The establishment, however, was closed before his return, and Mr. Emery entered into business for himself as consulting engineer and patent expert, writing occasionally for the scientific papers. He had previously however been appointed consulting engineer of the United States Coast Survey and United States Revenue Marine, in connection with which' he was also made superintendent of some work for the supervising architect of the Treasury Department. Mr. Emery built several vessels for the United States Coast Survey, and was actively interested in the revival of the compound engine in this country. The first engine built for the Coast Survey steamer Hassler, was probably the most economical engine of its size ever constructed. Reports on file show that the vessel, with a displacement of 400 tons, made with half boiler power, a speed of eight knots, most of the time running a line of soundings, on a consumption of two and one half tons of coal per day. While in the naval service at the Novelty Iron Works, Mr. Emery was employed as consulting engineer by the Hecker Brothers of this city, to initiate and superintend repairs to the engines and the construction of new boilers, with such success that the output was increased fifty per cent in the larger mill. Mr. Emery was at this time a strong advocate of the compound engine and was criticized in some quarters on that account, but his judgment has been amply vindicated by the later performances of compound engines.

The Coast Survey appointment terminated when the naval engineers were ordered to the vessels; that to the Revenue Marine was continued some twenty-one years, until 1891. In this service the machinery for twenty new vessels was constructed under Mr. Emery's direction, and that of all the others several times repaired and remodeled. In 1874 an opportunity was embraced to place three different types of machinery in three hulls of the same size, one a long stroke, high pressure, condensing engine; another a short stroke, low pressure, condensing engine; and a third a fore-and-aft, compound, condensing engine. These vessels as well as a subsequent one, in which the cylinder of a high-pressure, condensing engine was jacketed, were thoroughly tested by a joint board of engineers from the Navy and Treasury departments, Chief Engineer Charles H. Loring, representing the former, and Mr. Emery the latter. The results were at the time the only reliable ones extant, and the printed reports and an analysis of the same by Mr. Emery were copied in the text books and technical literature at home and abroad. The degree of Doctor of Philosophy was conferred upon him soon afterward, by the University of the City of New York.

Dr. Emery was one of the judges at the Philadelphia Centennial Exhibition, on engines, pumps and mechanical appliances, and an associate member of the scientific committee on musical instruments, electrical and other scientific apparatus, and was assigned to the position of assistant to Lord Kelvin, then Sir William Thomson. He was also appointed one of the judges in the Electrical Department of the Columbian Exposition at Chicago in 1893, and was placed on the Committee to which was assigned the examination of dynamos and motors.

In 1879, Dr. Emery while continuing his connection with the Revenue Service, became the chief engineer and finally manager of the New York Steam Company. He designed and built the entire plant, providing four stories of boilers, aggregating 16,000 horse-power at the Cortlandt street station, using wrought-iron pipes of the largest size it was then possible to obtain, (some fifteen inches and even sixteen inches in diameter), designing special expansion joints and other details, and making the work a complete mechanical success. Steam was supplied through service pipes, eight and ten inches in diameter, to buildings like the Produce Exchange, the Mutual Life building, and finally the New York Court House and Post Office, at distances of one half to three quarters of a mile from the station. The plant operated very satisfactorily and still continues to do so under the original pressure of eighty to eighty-five pounds. The steam company had the prospect of an enormous business before it, but the situation has been greatly changed by the subsequent growth of the electrical industries, especially the transmission of light and power over considerable distances. In consequence of this a great many power-users take electric power from central stations, who would otherwise take steam from the steam company. On the other hand however, there are office buildings in the district served by the steam company, which have their own plants including dynamos, engines and boilers complete, but which take steam for their engines from the steam company in preference to firing their own boilers. A smaller steam station was erected on Fifty-eighth Street near Madison Avenue. Dr. Emery resigned from the steam company in October, 1887, up to which time there had been expended on the work nearly two millions of dollars, and continued business as consulting engineer and engineering expert in relation both to practical matters of engineering and those arising from litigation in patent cases, condemnations of water power, etc. Dr. Emery has been consulting engineer for the terminal facilities of the New York and Brooklyn Bridge and several of the principal plants of the Edison Electric Illuminating Company. He was for a number of years consulting engineer for the City of Fall River, Massachusetts, and prominent in connection with the compromise of the difficulties between that city and mill owners; resulting in a novel agreement, based on his report, by which water was to be thereafter furnished to the city from the Watuppa ponds in consideration of the abatement of taxes on water power. He has been connected with the building of steam yachts, a subway company and a number of similar enterprises. He has lectured at Cornell University, and other educational institutions, and while in the government service was chairman of the engineering examining boards of the United States Revenue Marine. Many of his lectures were published in the *Scientific American Supplement.*

Besides being a member of this INSTITUTE, Dr. Emery was also a member of the following bodies. The American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Association for the Advancement of Science, the British Institution of Civil Engineers, from which he received a Watt medal and a Telford premium for an approved paper, and the Brooklyn Institute of Arts and Sciences, in which institution he held the office of president of the department of engineering.

In his official capacity of judge at the Centennial Exhibition at Philadelphia, Dr. Emery had an excellent opportunity to estimate the future possibilities of the various branches of applied science, and being impressed with the prospects of electricity, he determined to study that science, but several years elapsed before he had any business or professional connection with electrical matters. However, he never lost his personal interest in electricity, and as the different branches of the industry developed, he kept in touch with them. On June 26th, 1891, he was elected to this INSTITUTE, and on April 19th, 1892, he was transferred to full membership. On October 23d, 1895, he was appointed to the Board of Examiners, and at the next meeting of that body on November 6th, he was elected chairman, which office he held at the time of his death. Since his connection with the INSTITUTE, Dr. Emery has read four papers before the meetings, besides being a very frequent participant in the discussions. His papers were as follows; at the general meeting of the Institute at Chicago, June 6th, 1892, a paper on "The Relation Between Magnetomotive Force and Magnetization" at the local meeting at New York, March 21st, 1893, a paper on "The Cost of Steam Power" at the general meeting at Niagara Falls, June 26th, 1895, another paper on the same subject and also a paper on "Alternating Current Curves." The papers on the cost of steam power are of great practical utility, and have become a standard of reference.

[See page 327, May issue.]

[COMMUNICATED AFTER ADJOURNMENT BY MR. A. VOSMAER.]

We practical men must congratulate Mr. Steinmetz for such an excellent and valuable paper as he has given. Experimenting myself in the line of high tensions it has often puzzled me how to fix minimum distances for different parts of instruments and transformers, and information was not to be had.

We can find some tables of spark lengths and potential differences, but scientific men like Baille, Paschan, Liebig, and others do not seem to have the slightest interest for alternating current, and do not generally extend their series wide enough.

It matters very little indeed to us what tension corresponds to a spark of a fifteen thousandth of a millimetre or what it is in hydrogen or at low pressures, but it is of the greatest practical value to know the spark lengths in air and for alternating current.

I would like to ask two questions, how many were the frequencies of his high frequency ironclad alternator and does Mr. Steinmetz consider a variation in the frequency from 40 to 125 large enough to permit any conclusion as to the apparent independence of striking distance and frequency, it being well known that at very high frequencies the tendency for sparking is greatly diminished.

Has Mr. Steinmetz also experimented with a specially constructed high-tension transformer, and in consequence of experience preferred four transformers in series with the complication of insulation by transformers?

We have a one kilowatt 40,000-volt transformer in constant use, it never has given any trouble, but it was specially designed for the purpose, oil insulation being used though the secondary coils were made with the utmost care.

We have had opportunity to see a 100,000-volt, 15-kilowatt transformer designed and constructed by Schneller, which does not even have oil insulation and has nothing else but air insulation; that is all high-tension parts are spaced wide enough to prevent sparking.

For ourselves we preferred oil, because the dimensions of the air-insulated transformer are rather out of proportion; which means a great deal of copper in the secondary, and oil is cheaper than copper.

Nevertheless the transformer, in constant use, has always given full satisfaction. Schneller who has made a number of lower transformers used to couple these in series, *i. e.*, two of 30,000 volts each; preferred to construct one for 100,000 and used a factor of transformation of 1000 which is a pretty good figure.

The secondary tension could be easily measured because the secondary windings consisting of ten coils in series and one thus can measure one coil for itself with a static voltmeter.

As a matter of fact we have done the same for our transformer, there being eight coils connected alternately at the center part and at the periphery, just as is done for large induction coils, each coil, after having been placed a good many hours in hot ceresin standing 10,000 volts without puncturing.

I should prefer this to the arrangement given by Mr. Steinmetz as being far simpler.

The good behavior of Schneller's 100,000-volts transformer would suggest a similar behavior for one of 200,000 volts.

As said, Mr. Steinmetz's contribution to our knowledge about very high tension alternating currents is a most valuable one, and we express our hopes that he will investigate the dielectric strength of solid and fluid dielectrics in the same thorough way as he has done for air. The future will bring us very high tensions in common use, and the value of elaborate tests is beyond doubt as regards general interests.

Haarlem, Holland, July 24, 1898.

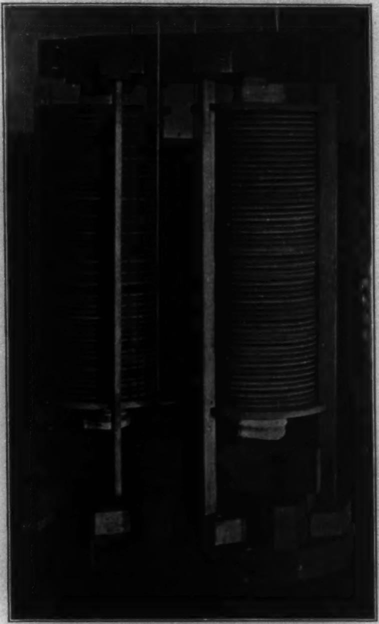
[Communicated after Adjournment by Harold B. Smith.]

The valuable paper of Mr. Steinmetz has to do with work on a subject which has been under investigation during the past year by Messrs. E. B. Paine and H. E. Gough, graduate students under my direction at the Worcester Polytechnic Institute.

Their thesis on "High Potential Discharges in Dielectrics" involved the construction of a 150,000-volt transformer of 20-K.W. capacity, which is interesting in that with a *single* transformer a ratio of 1 : 1500 was secured, and the transformer has been operated to potentials above 170,000 volts without failure.

The transformer was operated from the secondary circuit of a bank of smaller transformers, the potential of which was varied as desired from a small value to as high as 115 volts. The primaries of the smaller transformers were supplied with current from a 30 K. W. Westinghouse smooth core alternator, giving practically a sine wave of E. M. F. at a frequency of 133 cycles. The accompanying cut shows the construction of this transformer which was immersed in a tank of kerosene oil, preliminary experiments proving the value of this oil under the given conditions.

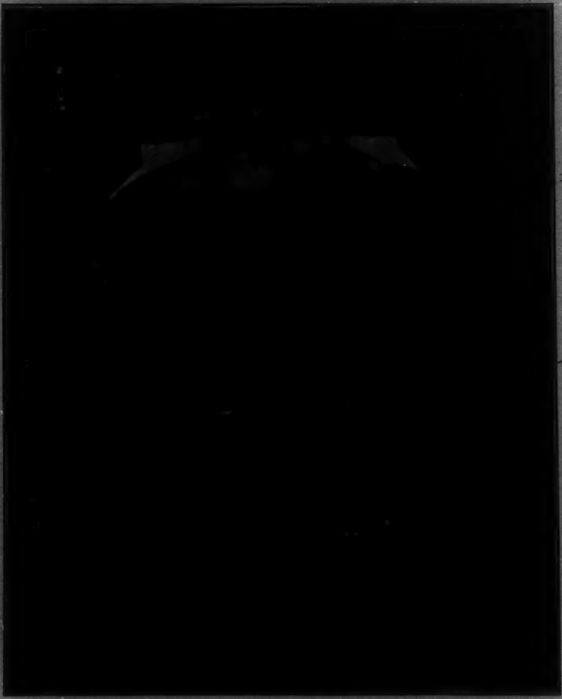
The investigation of various dielectrics included a series of tests on the dielectric strength of air, and, while not as complete for this dielectric as those of Mr. Steinmetz, are of value in this connection as they entirely corroborate his results by an entirely independent investigation under nearly the same conditions as to methods of experimentation and apparatus used. There is no occasion to repeat the tabulation of our tests with sharp points



No. 1.—150,000-Volt Transformer.

No. 2.—Eighteen Inch Discharge.

No. 3.—Thirty-one Inch Discharge on String.



No. 4.—The Breaking Down of a High Potential Insulator at 90,000-Volts, Showing Material Ejected from Point of Rupture.

and spheres of small radius, as they would add nothing to results given by Mr. Steinmetz further than to add data agreeing almost exactly with that obtained by him.

Our results show a corresponding constancy and reliability of length of spark gap as a measure of high potentials.

A photograph is shown of a discharge between ¼" spherical terminals 18 inches apart which exhibits the same characteristics as those obtained by Mr. Steinmetz at shorter lengths.[1] This discharge took place at a virtual voltage of 167,000 volts, corresponding to a maximum potential of 236,000 volts, and required at the transformer about fifty horse-power during its existence.

A discharge along a moistened string 31 inches long and the breaking down of a high potential porcelain insulator at 90,000 volts are also shown.

HAROLD B. SMITH.

Worcester Polytechnic Institute, July 6th, 1898.

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[1] "Photographic Investigation of a 150,000 Volt Power Discharge." *Electrical World*, March 5, 1898.

ASSOCIATE MEMBERS ELECTED AND TRANSFERRED.

Elected at Executive Committee Meeting, New York, June 24th, 1898.

Name.	Address.	Endorsed by
ALLEN, WALTER CUMMINGS,	Inspector of Electric Lighting, Government of District of Columbia, District Building, Washington, D. C.	O. T. Crosby. J. B. Cahoon. W. G. Ely, Jr.
ARMSTRONG, ALBERT H.	Electrical Engineer, General Electric Co., Schenectady, N. Y.	C. P. Steinmetz. James Lyman. Jin Tachihara.
DAMON, GEO. A.	With B. J. Arnold Electrical Engineer, 1541 Marquette Building, Chicago, Ill.	B. J. Arnold. Henry S. Carhart. R. B. Owens.
DEXTER, FRANK H.	Student, Cornell University, residence, 51 Huestis St , Ithaca, N. Y.	Fred'k Bedell. Edw. L. Nichols. Ernest Merritt. H. J. Ryan.
DOWNING, P. M.	Supt. Electrical Dept. Blue Lakes Water Co., Blue Lakes City. via Jackson, Cala.	F. A. C. Perrine. F. V. T. Lee. T. E. Theberath.
LYONS, JOSEPH,	Patent Solicitor, with Gustav Bissing, 918 G. Street, Washington, D. C.	Edw. J. Houston. A. E. Kennelly. F. L. Freeman.

Total, 6.

TRANSFERRED TO MEMBERSHIP.

Approved by Board of Examiners, May 11th, 1898.

Name.	Address.	Endorsed by
THRESHER, ALFRED A.	Electrical Engineer, and Proprietor, Thresher Electric Co., Dayton, O.	
JACKSON, WILLIAM B.	New York and Staten Island Electric Co., West New Brighton, N. Y.	
LINCOLN, PAUL M.	Electrical Superintendent Cataract Construction Co., Niagara Falls, N. Y.	
REID, THORBURN.	Consulting Electrical Engineer, 120 Liberty Street, New York City.	
GOSSLER, PHILIP GREEN.	Electrical Engineer, Royal Electric Co., Montreal, P. Q.	
THEBERATH, THEODORE E.	Pacific Coast Engineer, Stanley Electric Co., San Francisco, Cal.	
PEDERSEN, FREDERICK, M.	Assistant Electrical Engineer, Crocker-Wheeler Electric Co., New York City.	
DUNLAP, WILL K.	Electrical Engineer, Westinghouse E. and M. Co., Niagara Falls, N. Y.	

Elected at Executive Committee Meeting, New York, July 27th, 1898.

Name.	Address.	Endorsed by
ADAMS, ERNEST K.	Graduate Student, Columbia University; residence, 455 Madison Ave., New York City.	F. B. Crocker. S.G.F. Townsend. W. H. Freedman.

Martin, John	Agent, Stanley Electric M'f'g. Co., 300 California Street, San Francisco, Cal.	J. A. Lighthipe. F. F. Barbour. F. A. C. Perrine.
Meyer, Hans S.	Electrical Engineer, General Electric Co.; residence, Hotel Edison, Schenectady, N. Y.	C. P. Steinmetz. Eskil Berg. J. Tachihara.
Pearson, Fred'k J.	Supt. of Construction, Western Electric Co., 1510 Howard St., Omaha, Neb.	R. B. Owens. W. F. White. R. W. Pope.
Wordingham, Chas. H.	City Electrical Engineer, The Manchester Corporation Electric Light Station, Dickinson Street, Manchester, England.	W. H. Preece. H. F. Parshall. E. Danielson. W. M. Mordey.

Total 5.

TRANSFERRED TO MEMBERSHIP.

Approved by Board of Examiners, June 23rd, 1898.

White, William Fullerton	General Manager, New Omaha Thomson-Houston Electric Light Co., Omaha, Neb.

APPLICATIONS FOR MEMBERSHIP.

Applications have been received from the following candidates for Associate Membership, which will be acted upon by Council at its meeting, Sept. 28 1898.

Walter H. Coleman, Andover, Mass.
Henry L. Doherty, Madison, Wis.
Kempster B. Miller, Chicago, Ill.
John West Thompson, Guadalajara, Mexico.
Henri Tripier, Paris, France.
Herbert A. Wagner, St. Louis, Mo.
Wm. Henry Williams, Bozeman, Montana.
Gilbert Rosenbusch, Paris, France.
George W. Frank, Jr., Kearney, Neb.
Frederick W. Carter, London, Eng.
R. H. Mansfield, Bronxville, N. Y.

Any member objecting to the election of any of the above candidates, should notify the Secretary to that effect prior to Sept. 28th, 1898.

NOTICE.

The second instalment of the report of the Omaha meeting, having been lost in the mail, and the Stenographer's original notes accidentally destroyed by the janitor, the discussion of the papers cannot be printed, excepting in such cases as the participants have kindly sent the gist of their remarks in response to the request of the President.

RALPH W. POPE,
Secretary.

New York, September 12, 1898.

GALILEO FERRARIS.

A Memorial.

The *Associazione Elettrotecnica Italiana* of Milan, Italy, has undertaken the accumulation of a fund for the purpose of erecting a suitable monument in memory of the late Professor Galileo Ferraris. In order to enable his many American friends to participate in this worthy object, which will assume the form of an international tribute, the Executive Committee has authorized the Secretary to receive any contributions that may be made, and which will be forwarded to the Italian Society, through the agency of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Remittances by check or money order will be duly acknowledged, and should be made payable to the undersigned.

RALPH W. POPE,
Secretary.

NEW YORK, June 24th, 1898.

The Institute Badge.

The Council has authorized the sale of Badges of the new design at the following prices, for the different styles.

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The monthly parts distributed to members and subscribers during the year, are not intended for binding, but simply for the use of readers, as the work of the Institute progresses

After printing the monthly, the papers and discussions are revised, repaged, and the sheets for the annual volume printed from the corrected type, and laid aside till the close of the year. As the index is made for the volume and **not** for the monthly parts, the complete volume sent at the end of the year becomes the permanent record. Upon its receipt the monthly parts are superfluous. They may be returned to this office at our expense, as there is a continual demand for separate copies of papers.

RALPH W. POPE, Secretary.

COPPER WIRE TABLE.

This table gives the WEIGHTS, LENGTHS and RESISTANCES of cool, warm, and hot wires of

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Mailed separately, price 10 cents.

RALPH W. POPE, Secretary,
26 Cortlandt Street,
New York City.

Contents of Vol. XIV, 1897.

Electrically Driven Vehicles. A Topical Discussion. No. 1, January, 1897. The Conductivity of Incandescent Carbon Filaments, and of the Space Surrounding them. (Illustrated.) By John W. Howell. No 2. February, 1897. The Influence of Heat Treatment Upon the Magnetic Properties of Steel and Iron (Illustrated) By Dr. Karl E. Guthe. No 3, March, 1897. The Synchronograph. (Illustrated.) By A. C. Crehore and G. O. Squier. No. 4, April, 1897. Application of Hyperbolic Analysis to the Discharge of a Condenser. By Alexander MacFarlane The Alternating Current Induction Motor. (Illustrated) By C. P. Steinmetz. A New Form of Induction Coil. By Elihu Thomson. The Effect of Heat on Insulating Material. By Putnam A. Bates and W. C. Barnes. No. 5, May, 1897. The Effect of Armature Inductance upon the Electromotive Force Curves of an Alternator. (Illustrated.) By W. E. Goldsborough. Electric Metering from the Station Standpoint. By C. D. Haskins. Electric Traction.—Notes on the Application of Electrical Motive Power to Railway Service, with illustrations from the Practice of the Metropolitan Elevated Road of Chicago. (Illustrated.) By M. H. Gerry, Jr. Development of the Fire Alarm Telegraph. By Adam Bosch. The Cost of Steam Power. By Horatio A. Foster. Nos. 6 and 7, June and July, 1897. The Precision of Electrical Engineering. By F. B Crocker. The Enclosed Arc Lamp. (Illustrated) By W. H. Freedman. Armature Reactions in a Rotary Converter. (Illustrated.) By R. B. Owens. The Economy and Utility of Electrical Cooking Apparatus. By J. P. Jackson. Nos. 8 and 9, August and September, 1897. 14th General Meeting. Discussion. No. 10. October. 1897. The National Electrical Code. No. 11, November, 1897. Catalogue of Membership, No. 12. December, 1897.

Contents of Vol. XV, 1898, far as Published.

The Development of Electric Cableways. (Illustrated.) By Richard Lamb. Sparking, its Cause and Effects. (Illustrated.) By Thorburn Reid. Wireless Telegraphy. By W. J. Clarke. No 1, January, 1898. The Standardizing of Generators Motors and Transformers. (A Topical Discussion.) Single Phase Induction Motor. (Illustrated) By Charles P. Steinmetz. No. 2, February, 1898. Insulation and Conduction. (Illustrated.) By Reginald A. Fessenden. No. 3, March 1898. An Economy Test of a Central Station. (Illustrated.) By W. E. Goldsborough. A Novel Form of Thermo-Electric Battery. (Illustrated.) By Charles J. Reed. No. 4, April, 1898. Dielectric Strength of Air. (Illustrated.) By Charles P. Steinmetz. Two-Wire Distributing Systems and Lamps, 200-240 Volts. By John W. Howell. A Capillary Electrometer for Electrical Measurements. (Illustrated.) By Charles F. Burgess. Alternating Current Transformers from the Station Manager's Viewpoint. By W. F. White. Some Phases of the Rapid Transit Problem. (Illustrated.) By A. H. Armstrong. Preliminary Report of the Committee on Standardization. Power Transmission and Distribution for Railway Work (Illustrated.) By Ernest J. Berg. The Commutated Curve of a Composite-Wound Alternator. (Illustrated.) By D. C. Jackson. Some Tests with an Induction Generator. (Illustrated.) By A. F. McKissick. The Evolution of the Line Signal. (Illustrated.) By Arthur V. Abbott. A Modern Electric Central Station. (Illustrated) By George A Damon. The Graphical Treatment of Alternating Currents in Branching Circuits. (Illustrated.) By Dr. H. T. Eddy. No. 5, May, 1898. The Present Status of Electrical Engineering. (Inaugural Address.) By A. E. Kennelly, President. No. 6 and 7, June and July, 1898.

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